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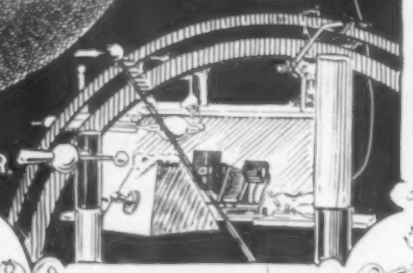
THE AMERICAN X-RAY JOURNAL

A MONTHLY DEVOTED TO THE PRACTICAL APPLICATION OF THE NEW SCIENCE AND TO THE PHYSICAL IMPROVEMENT OF MAN.



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Devoted to Practical X-Ray Work and Allied Arts and Sciences.

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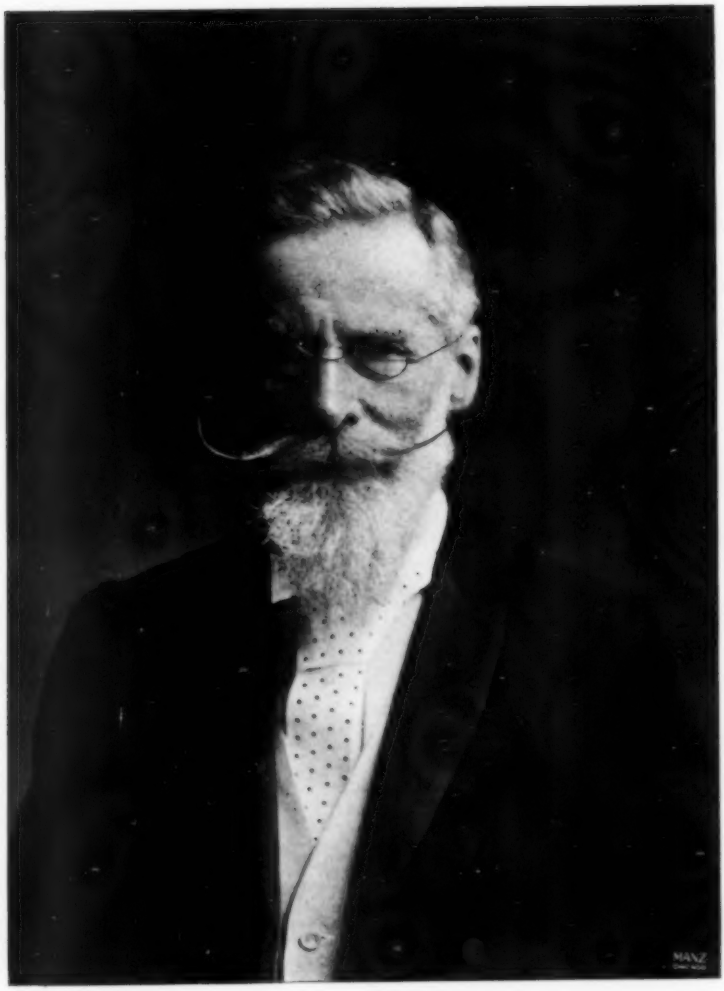

SIR WILLIAM CROOKES, F. R. S.

The American X-Ray Journal.

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VOL. 4. *ST. LOUIS, APRIL, 1899.* *NO. 4.*

X-RAY ESSENTIALS--THE VALUE OF THE X-RAY FROM A DIAGNOSTIC AND THERAPEUTIC STANDPOINT.

Read before the Erie Railway Surgeons' meeting held in Chicago at the Grand Pacific Hotel on October 19, 1898 by Prof. H. P. Pratt, M. D. of Chicago.

It was the latter part of January of 1896 that Prof. Roentgen announced to the scientific world that he had succeeded in photographing the bones of the living skeleton. There has not been a discovery of such vast importance to the medical profession since the discovery of the circulation of the blood by Harvey. Before the telegraph wires were fairly cold, giving to the world this intelligence, every scientist having an available, or able to secure an available apparatus, commenced to experiment independently, endeavoring to prove or disprove said statement. After they had satisfied themselves as to its correctness, they then undertook to advance a theory which would be acceptable to the scientific world.

The Century Dictionary gives the following definition of the x-ray or Roentgen ray, as it is sometimes termed:

The x-ray, or Roentgen ray, is a form of radiation having characteristic and distinctive properties discovered by Prof. Wilhelm Konrad Roentgen, of Wurtzberg, as announced by him in December, 1895. He said that the discharge of a Ruhmkorff coil through a vacuum tube produced a form of radiation external to the latter, which has the property of causing various substances to fluoresce, affecting the ordinary photographic plate, like light (although itself invisible) and of penetrating opaque bodies in various degrees, according to their density and relative thickness; platinum, lead and silver being quite opaque, while aluminum, wood and paper are quite transparent.

This is a statement that came from Prof. Roentgen direct; in the above definition he is dealing with the effects "only," and does not even suggest the cause or first principle.

Numerous hypothesis were advanced from time to time by such men as Edison, Tesla, Prof. J. J. Thompson, Elihu Thompson, Sir Wm. Thompson, Dr. Lodge and others, and yet no two of them agree.

In January, 1894, Prof. Phillip Leonard is credited with being the first to discover the phenomenon that we now term the X or Roentgen ray. He was experimenting with a similar apparatus to that in use at the present time, for the production of the shadowgraph, endeavoring to determine whether the cathode ray could be transmitted to the outside of a vacuum tube. This suggestion was made to him first by Prof. Hertz. "His interest, therefore, in this

discovery was so great that his researches extended to the minutest details." From all that can be learned, Phillip Leonard is entitled to all of the credit for the discovery of the X or Roentgen ray, because first, he not only used the same kind of apparatus for producing it, but he actually photographed coins in boxes, etc. These first experiments were published in "Wiedermann's Annalen," in January, 1894, and October, 1895. Had he placed his hand on a photograph plate for a few minutes, and then had the plate developed, Prof. Roentgen's name would never have been known. Since the announcement made in 1894 and '95, by Prof. Leonard, there has not been a change in apparatus or an improvement, as far as principle goes, down to the present date. The only improvements made, were purely mechanical, perfecting the old apparatus.

I will refrain from entering into any further discussion, in regard to the history of the x-ray, etc., but confine myself to the essentials for their production. The first apparatus for the production of the x-ray, was designed as I said before, and worked by Prof. Leonard (Fig. 2), which consists of a Ruhmkorff coil (R,) a battery (b,) and a vacuum tube (t.) The Ruhmkorff coil consists of a primary (x,) and a secondary wire (y,) of different lengths and sizes surrounding a core of soft iron wire (z.) Into the primary circuit of the coil, a battery or an electric generator (b,) and a vibrator or interrupter (d,) are introduced.

The two terminal wires of the secondary being attached to a vacuum tube (t.) There are several forms of vacuum tubes made, the difference being only in shape and degree of vacuum. They are named after the one that suggested the form, such as the Plucker, the Hittorf, the Geissler, the Leonard, the Crookes tubes, etc. The Geissler tube having a low vacuum, while the Crookes tubes are carried to a high degree.

In the Geissler tube the vacuum is estimated to be about one thousandth of an atmosphere, while that of the Crookes tubes, the vacuum is carried to an extreme degree, about one millionth of an atmosphere.

There are several different kinds of apparatus that can be used for the production of the x-ray, such as Static machines, Magneto-machines in connection with condensors, etc.

Now if you will follow me very closely, I think I will be able to satisfy you as to the nature of the x-ray. I think it is very simple. Before we can appreciate what it is, let us take up and discuss the following questions:

First: What is electricity?
What is an electrical circuit?
What is an electrical current?
What is induction?
What is resistance?
What is magnetism?
What are lines of Magnetic force?
What is electrolysis?
What is polarity?

The first question is, what is electricity? This is a question that has been discussed by the scientific world for years, and yet they have not arrived at a proper definition. I do not care what electricity is; but we do know of a phenomenon to which we give the name of electricity. If we take an ordinary bar magnet, properly magnetized, capable of attracting iron, nickel, cobalt etc., and analyze it very closely, we are bound to arrive at a definite conclusion.

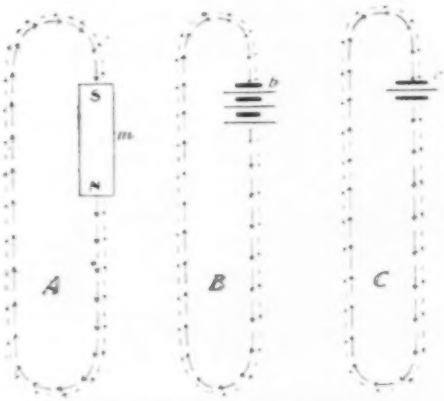
For instance, if we take the north pole of this bar magnet and approach it to the north pole of a compass needle, we find that the two north poles repel. If we present the opposite poles, we find they also, repel; but if we present

the north pole of one, to the south pole of the other, immediately there is an attraction.

Now let us take this bar magnet and divide and subdivide it into particles so small that it requires a magnifying glass to see them. Every particle of the magnet will exhibit the phenomenon on the one hand of attraction, and on the other hand, of repulsion when presented to like particles.

We are bound to arrive at this conclusion, that all particles, that is, every particle of this magnet, is a magnet in itself, and the large magnet is nothing more or less than an accumulation of small magnets.

This takes us back to the original



hypothesis which was suggested so many years ago, especially by Faraday, that each molecule in the universe is an independent center of force, and that each molecule has, and retains a definite and constant amount of electrical force or energy, and that which is known as chemism, or chemical affinity, is nothing more than this electrical force, and that this force is what holds matter together.

If we should sprinkle iron filings on a glass plate and place a horse shoe magnet below the plate, we would find that all of the particles will be arranged in series and in parallel with the molecules of the horse shoe magnet, having all the north poles of the particles or molecules point in one direction, and all of the south poles in the opposite direction. Now if we substitute for this horse-shoe magnet, a temporary magnet of soft iron, with coils arranged in circuit, attached to a battery with a reversing switch, and change the direction of the current several times, we will find that the iron filings will turn in the opposite direction with every alternation of the current; they will have the appearance of turning within their own plane. My definition of *electricity* is a persistent force which is a part of the atomic structure of matter, and it exhibits the phenomena of attraction and repulsion.

What is an electrical circuit? (Fig. 1)

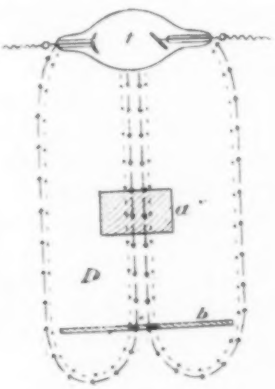


Fig. 1.

An electrical circuit is a series of molecules arranged in parallel, each molecule being a magnet or an equivalent of one. When so arranged, all of the north poles of the molecules point in one direction, and all of the South poles point in the opposite direction. If the north poles of a portion of the molecules pointed in one direction, and the north poles of the remainder pointed in the opposite direction, we would have two repelling forces coming together, and it would be impossible to establish a circuit.

What is an electrical current?

An electrical current is an accumulation of polarized molecules in a circuit;

the greater the number of molecules arranged in parallel, the stronger the current and vice versa. "The use of the word current has its advantages, and helps to convey ideas which are in accordance with observed effects; but the actual passage of a fluid in either direction is a matter of doubt, and in the opinion of Faraday, does not take place; he believing than the resulting phenomena are caused by a polarization of the molecules of the medium."

What is induction?

Induction is the result of a physical force which is brought to bear upon the molecular structure of matter, changing the relation between the molecules, causing them to be arranged in series in juxtaposition, and in parallel with the molecules of said initial force.

What is resistance?

Resistance is the condition or property of matter which opposes the rearrangement of the molecules.

What is magnetism?

Magnetism is the polarized condition of matter.

What are lines of magnetic force?

An endless chain of molecules arranged in series, each molecule representing an individual line of force; the greater the number of molecules added to the chain, the longer the line of force.

Electrolysis is the disassociation of the elements of a compound by the aid of electrical energy. (Fig. 3.)

Polarity: The having two opposite poles.

What is meant by potential?

Electrical pressure or force.

What is the unit of potential or electro-motive force called?

The unit of potential or electro-motive force is called a volt. The Daniell cell being taken as a standard, representing 1 079 volts.

What is the unit of resistance called?

The unit of resistance is called the Ohm. In 1827, Dr. George F. Ohm formulated his famous law, that the electro-motive force divided by the resistance is equal to the strength of the current.

Legal Ohm: The resistance of a column of mercury one square millimetre in cross section and 106 centimetres in length, at the temperature of 32 degrees F. This value of the Ohm was adopted by the International Electric Congress in 1884, as a value that should be accepted internationally as the true value of the Ohm.

What is the unit of current called?

The unit of current is called the ampere.

A milli-ampere is one-thousandth of an ampere.

THE ELECTRO-CHEMICAL SERIES.

Berzelius's final series stands thus:

Electro-Negative.			
Oxygen.	Boron.	Mercury.	Thorium.
Sulphur.	Carbon.	Silver.	Zinconium.
Selenium.	Antimony.	Copper.	Aluminum.
Nitrogen.	Tellurium.	Bismuth.	Didymium.
Fluorine.	Tantalum.	Tin.	Lanthanum.
Chlorine.	Titanium.	Lead.	Yttrium.
Bromine.	Silicon.	Cadmium.	Glucinum.
Iodine.	Hydrogen.	Cobalt.	Magnesium.
Phosphorus.	Gold.	Nickel.	Calcium.
Arsenic.	Osmium.	Iron.	Strontium.
Chromium.	Indium.	Zinc.	Barium.
Vanadium.	Platinum.	Manganese.	Lithium.
Molybdenum.	Rhodium.	Uranium.	Sodium.
Tungsten.	Palladium.	Cerium.	Potassium.
			Electro-Positive.

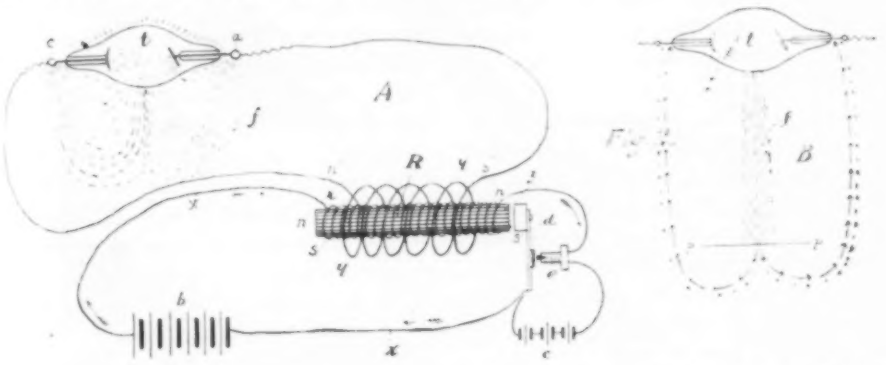
We have about seventy elements so far discovered, each one of these elements having a given electrical force, or pull, and each bearing a given relation to the other. For instance, Berzelius's according to his final series, claims that oxygen and sulphur are the strongest electro-negative, while potassium and sodium, are the strongest electro-positive.

Note the relation between all of these different elements. The two extremes will break up or separate any of the intervening elements when they are arranged in compound.

Note the relation in the list between hydrogen, the electro-positive element and So_4 the electro-negative radical of

$H_2 So_4$. Compare them with zinc which is stronger electro-positive than hydrogen: now imagine that every one of these sixty odd elements have a definite and constant pull, or, in other words, imagine that the oxygen and sulphur, the electro-negative radical on one hand represents a very powerful woman, and that zinc, an electro-positive on the other hand, a powerful man; but not as powerful a man as sodium or potassium. The intervening elements are weaker in strength in proportion to their place in the list.

Now let us go back to what takes place in a battery which produces the force that excites the primary wire of the Ruhmkorff coil. (Fig. 2.) Take for instance the form of battery used by Phillip Leonard, or the ordinary sulphuric acid battery (Fig 3), with zinc and platinum elements. Now, in refering to this list we find that H_2 representing the electro-positive element and the So_4 the electro-negative radical of the solution $H_2 So_4$ we find by referring to the list that So_4 has a greater affinity for zinc than for hydrogen, it standing in the same relation as a strong man would to a weak one. Consequently hydrogen is driven off and the So_4 combines with zinc, converting the sulphate of hydrogen into the sulphate of zinc; the force that is generated by the change, is simply enormous. It is sufficient to cause a rearrangement of the molecular structure of a telegraph wire around the globe. When this change takes place, the force generated causes a rearrangement of the molecules of the wire in the same manner and following the same law regarding direction as in the magnet described a few moments ago, in which all of the north poles point in one direction, and the south poles in the opposite direction, so far as to the initial force that energizes the primary circuit. To energize the secondary coil a circuit breaker or interrupter is introduced. This primary wire is of low resistance. Surrounding this primary wire, properly insulated from it, we have the secondary wire. The molecules in the secondary wire are arranged in the same manner as the



molecules in the primary wires when excited; that is to say, they are arranged in series and in parallel. Whenever a current passes in one direction in a primary wire a current is set up in the secondary wire in the opposite direction. So when we make and break a circuit, we get a complete reversal of the current; that is to say, when the current is made, or when the battery is connected in circuit, the molecules of the primary wire are arranged in series and in parallel in a definite direction, while in the secondary wire the molecules are arranged in the opposite direction; but when we break the circuit the molecules in the primary wire are reversed, which in turn produces a reversal in the sec-

ondary wire. So in this secondary wire the current generated must be alternating in character. (Fig. 2.) Now, we have followed a line of thought from the point of generation or the first cause, to the delivery of a current to a vacuum tube. Now, let us see what takes place in a vacuum tube. The tubes we have here tonight are of focus type. The one electrode being of aluminum, called the cathode, the other electrode being of platinum, termed the anod . These two terms are wrongfully used, as they mean a positive and negative, or the same as north and south poles, when applied to the body. With an alternating current in the secondary wire, how is it possible to have a definite positive and negative terminal connected with the vacuum tube? It is true that the force at one terminal, called the cathode, is stronger than the other, not by virtue of its being negative or positive, or cathode or anode; but by having a shunt introduced into the primary circuit, cutting down the discharge, so, when the current is made, the primary wire acting as a shunt, cuts down the force that otherwise would be equal. If it were not from this fact alone, the x-ray would not have been discovered, at least to date.

Now we come to the vacuum tube. This vacuum tube is constructed of the best German glass, as free from all metallic substances as possible, although not essential. It is exhausted by use of an air pump until there is comparatively a few molecules of gases left. When the tube is energized, the same law and the same phenomenon takes place in the tube as takes place when the impression passes over the wire to the tube. The molecules of the tube are all arranged in series and in parallel, and following the same law that governs all magnets, the outside of the tube being electro-positive and the inside electro-negative. (Fig. 2.) The tube is nothing more or less than an ordinary condensor and discharges in the same manner. The tube is really a magnet and it follows the law that govern magnets. If we take an ordinary bar magnet, or a piece of steel, properly hardened, without subjecting it to a magnetic influence, and then take a hammer and tap on the end of the steel bar, it is simply a matter of time until the whole bar will be magnetized. The magnetization is due to the hammering, which has produced a complete change of the molecules of the steel, arranging them in series and in parallel, in the same manner and way as they are arranged in a telegraph wire when the electrical impressions are being transmitted over it. Now this tube, as I said before, is exhausted to about one millionth atmosphere. There are now a comparatively few molecules of gas in comparison with what was there before the pump was applied. When the tube is excited by the coil the molecules in the tube are agitated and a circuit is established in the tube, causing the molecules of gas in the tube to be arranged in the same manner as the molecules of the wire are arranged. With every oscillation, or every break of current in the primary circuit it produces an alternation and change in the molecules in the vacuum tube, but, owing to the shunt in the primary circuit one pole or one side of the secondary wire is a trifle stronger than the other. The difference in the strength of the two causes the molecules of gas to be thrown against the platinum disc or anode, rebounding, striking the surface of the tube setting up a terrific bombardment. This bombardment presents the same phenomenon as the tapping on the steel bar with a hammer, which not only causes the molecules of the tube to be arranged in series and in parallel, but the lines of force are projected out in a straight line several feet beyond the tube. The stronger the bombardment, the longer the lines of force. Figs. 2 and 4.

Imagine that tube to be an equivalent of a magnet. The lines of magnetic force thrown out from the tube will produce decomposition in the same manner as we would find in a bath were we producing electrolysis (Fig. 3.) In the electrolysis of water, Formulae H_2O we find that the hydrogen is repelled from the positive pole or anode, but attracted to the cathode. We also find that the oxygen is repelled from the cathode or negative pole, but attracted to the opposite anode. Why is this? The oxygen being electro-negative, and as like poles repel, the oxygen is repelled from the negative side but attracted to the opposite. In the case of hydrogen being

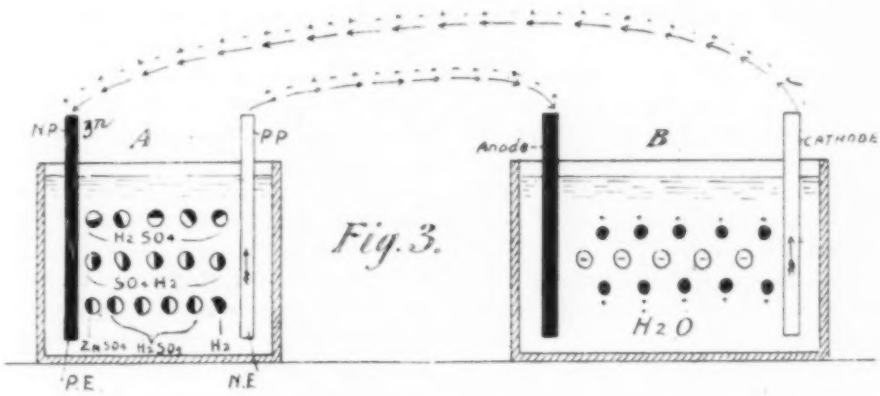


Fig. 3.

electro-positive, it is repelled from the positive side but attracted to the negative. This phenomenon takes place when we present a photographic plate, or a tungstate of calcium screen near a vacuum tube. The lines of force are thrown out from this Crooks tube in a definite direction, Figs. 2 and 4, producing decomposition with every discharge of the tube, and decomposing all substances in its track. In any chemical compound when decomposition takes place, for instance, a liquid, solid or gas, a spark is produced, we call this fluorescence. This is why in looking at a screen, the screen is lighted up by the x-ray, not from the light that is thrown from the tube, but from the electro-chemical changes that take place in the circuit, which reduces the chemicals on the screen into simpler compound or converts the bromide of silver on the photographic plate into oxide of silver. Figs. 2 and 4.

The amount of conversion depends upon the strength of the current. That, in return, depends upon the resistance of the circuit. The greater the resistance of circuit the less the change, the less the resistance of circuit, the greater the change. (Diagram C, Fig. 4.)

When we interpose between the screen or the photographic plate the hand or any part of the human body, what we see is not a picture of the bones, but the shadow of the difference of the resistance of a circuit, as determined by electro-chemical decomposition; bones affording a greater resistance to the circuit than the flesh, the decomposition is less and hence the shadow. This follows Ohm's law. The current is equal to the electro-motive force divided by the resistance.

Diagrams A, B, C and D, of Fig. 1, represent four different kinds of electrical circuits, the only difference between them being the source of electrical energy or initial force with a definite potential. So far as fundamental principles go, they are identical. The arrows represent polarized molecules or

molecules arranged in series and some in parallel, the arrows also indicating the direction of the lines of magnetic force.

Diagram A, of Fig. 1 represents a magnetic circuit; the initial force is a magnet as indicated by letter *m*, *n s* is its north and south poles. The potential of this circuit is over 100,000 volts. (This is disputed by some, but there is no doubt the potential is very high, even higher than the above figures).

Diagram B, of Fig 1 represents a galvanic circuit, the initial force indicated by letter *b* is a battery of three cells with a potential less than four volts.

Diagram C, of Fig. 1 represents a static circuit, the initial force as indicated by letter *c*, is a condenser or static machine, having a potential over 50,000 volts.

Diagram D, of Fig. 1 represents an x-ray circuit, the initial force comes from the vacuum tube (t_1) having a potential over 500,000 volts, letters *b* representing the photographic plate, letter *a* representing the object or body.

Diagram A and B, of Fig. 2, representing vacuum tubes (*t*) one disconnected, and the other in circuit with Ruhmkorff coil (R.)

Diagram A, Fig. 2, letter R, is a Ruhmkorff coil (*z*) is the wire core, with the primary wire (*x*) surrounding it, having battery (*b*) and circuit breaker or interrupter (*d*) with condensers (*c*) in circuit, surrounding the primary wire (*x*) and wire core (*z*) is the secondary wire (*y*) with its terminals attached to the electrodes (*e*) and (*a*) representing the cathode and anode of the vacuum tube (*t*.) The small (*f*) are lines of magnetic force thrown off from said tube. When the Ruhmkorff coil (R) is excited upon the closure of the circuit at the adjustable screw (*e*) the arrows indicating the direction of the current in the primary circuit. The letters (N. S.) (N' S') (N'' S'') representing the polarity of the primary coil, the wire core and secondary coil respectively, (*n*) representing the north pole and (*s*) the south pole. Upon the breaking of the circuit at (*e*) there is a complete reversal or change of polarity.

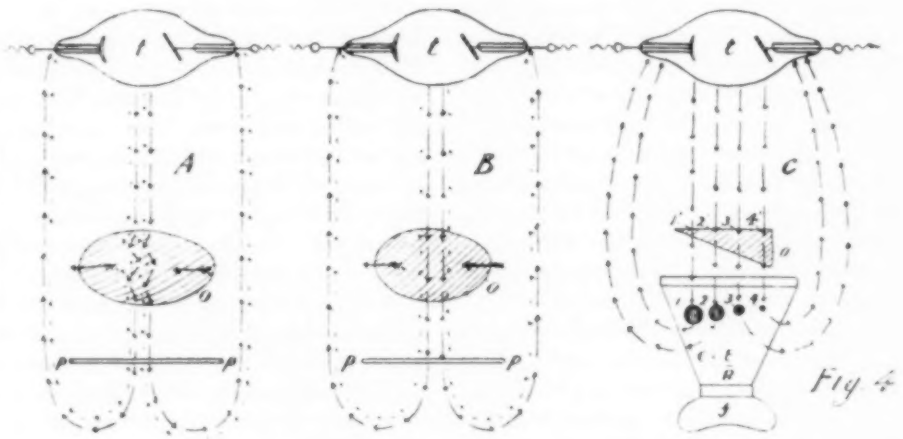
Diagram B, Fig. 2, representing a vacuum tube (*t*) with lines of magnetic force (*f*) concentrated and extending down to the photographic plate or screen (*pp*.) The arrows below the plate indicating the return circuit. As indicated by the direction of the arrow passing through the vacuum tube (t_1) of diagram B, Fig. 2, the outside of the tube is electro-positive, the inside electro-negative. Fig. 3 representing the electrolysis of water. A, is a sulphuric acid battery (*p e*) the positive element or zinc (*zn*;) (*ne*) is the negative element; the negative pole (*np*) and the positive pole (*pp*) are connected to the cathode and anode of the bath B, respectively, in which water H_2O is being decomposed. The arrows connecting the battery A with bath B are polarized molecules and indicating the direction of the magnetic lines of force. Fig. 4, illustrating 3 vacuum tubes of varied potential, showing the direction of the lines of magnetic force, the arrows representing polarized molecules arranged in series and in parallel with said initial force, the plus and minus signs indicate the north and south poles of the molecules.

Diagram A, Fig. 4 is an x-ray circuit with a vacuum tube (*t*) of low voltage, the object or body (*o*) with photographic plate or screen (*pp*) in circuit. Note the irregular position or direction of the arrows in object (*o*.) This condition takes place when the voltage of the vacuum tube is not sufficient to hold the lines of magnetic force or molecules, in series and in parallel, the object (*o*) or body exhibiting resistance or counter-force, consequently the lines of force thrown from the tube are reflected or refracted giving a distorted image on the photographic plate (*pp*.) For this rea-

son I have yet to see a good shadow-graph of the hip joint taken of a man weighing 200 pounds.

Diagram B, Fig. 4, is another x-ray circuit. Instead of the tube (*t*) being of low voltage, it is of high voltage. Observe the difference in effect on object (*o*). The molecules are held in series and in parallel, and hence the shadow is more perfect. To take a first-class shadow-graph of the bones through the body of a large man, it is necessary to have the voltage sufficiently high to hold the structure in series and in parallel, otherwise we would have a faulty picture.

Diagram C, Fig. 4, illustrates the vacuum tube (*t*) with a fluoroscope (*f*) and object (*o*) in circuit; the four dark circles marked 1, 2, 3, 4, on fluoroscope, indicate the difference in decomposition as recorded on the screen, the large circle indicating the greater decomposition, while the smaller one the lesser decomposition. The object (*o*) marked 1', 2', 3', 4', indicate a difference in resistance of the object to the x-ray indicated by the amount of decomposition recorded on fluoroscope marked 1, 2, 3, 4. It follows Ohm's law: $C=\frac{E}{R}$.



At the conclusion of the paper, which was a basis for argument, Dr. Pratt spoke at length, and the following is a summary of his remarks:

First, remember the difference in principle between the magnetic, galvanic, static currents and the x-ray is in potential only. They are all conditions of the same force. They are all electrical. (Note diagrams A, B, C, D, Fig. 1.) The following hypothesis was formulated by Dr. H. P. Pratt and published in all the daily papers several times during the months of February and March, 1896:

The x-ray is an electro-static phenomenon, an accumulation of the lines of magnetic force of high potential, and of short wave length in a circuit. (Note diagram B, Fig. 1, letter *f*, also diagram C, Fig. 4.) It decomposes every substance capable of being decomposed, in its path, and renders every substance over which it travels a conductor of electricity. (Note diagram A, B, C, of Fig. 4, also Fig. 3.) The result of said decomposition on the photographic plate or screen is the shadow, which is the difference of the resistance, of the circuit, determined by the amount of electro-chemical decomposition, (as recorded on the photographic plate or screen within a given time.) This follows Ohm's law: $C=\frac{E}{R}$.

For this reason I use the word sha-

dowgraph, instead of skiagraph, radiograph, etc. The word shadowgraph is in accordance with observed effects, and conveys a better idea as to what takes place.

THE VALUE OF THE X-RAY AS A DIAGNOSTIC AGENT.

The x-ray is proving invaluable to the surgeon. It not only enables him to determine the nature of a fracture or break, but abnormal conditions; enabling him to determine whether such fracture or break is properly set and whether such abnormal condition can be corrected with surgical interference. In fact the surgeon can reduce dislocation and set bones with the aid of the fluoroscope under the ray, having his assistant apply the bandages. The effect of the ray on the nerves is sedative, and in fact there is a partial anaesthesia produced. We are now able to detect abnormal condition in the softer tissues, such as tumor of the brain and body, diseases of the lungs, stomach, heart, liver, kidneys etc., locating stones in the kidney and bladder, as well as foreign bodies in the eyes.

While the x-ray is of advantage to the surgeon, it has its disadvantages. Ever since its discovery, especially in the last year every malicious person who can scrape up enough money to pay for a shadowgraph, is having one taken for the purpose of bringing a damage suit for personal injuries or malpractice. It is coming to this: That a surgeon is not safe unless he has a shadowgraph taken before and after each operation. It is surprising to see the number of damage suits now pending against corporations, individuals and especially surgeons for supposed injuries sustained or for malpractice, depending entirely on the shadowgraph as evidence. I will say the shadowgraph is not competent evidence because there is an opportunity for a great fraud to be perpetrated. Even the operator if he is not careful can be deceived himself. I have defended several corporations against shadowgraph, which showed a fracture where no fracture ever existed. An operator skilled in x-ray work, can deceive the most skilled if they are not on their guard. Now let us come to damages attending an exposure.

First of all, no person should be allowed by law, to do x-ray work unless he is an expert electrician as well as a physician. If he is not familiar with the electrical part of it, he can make shadowgraphs that are distorted and in every way unfit for evidence, and at the same time, he can do a great deal of damage. He ought to be a physician, so that he could determine as to the amount of force that should be used, in each particular case, and in case of injury he would be familiar with the methods of treatment. As I said before while the x-ray is valuable as a diagnostic agent, it has its disadvantages. Too great an exposure and too many exposures of the same part to the ray, may prove disastrous. For instance, I can recall several cases in which united fractures have reopened, the scar tissue being absorbed, due to many exposures to the x-ray and carelessness of the operator. I have seen a good deal of damage done not only to the skin, but to the deeper tissues. I know of two cases where the jawbone had been partially disintegrated and absorbed. This is due entirely to carelessness on the part of the operator, he not being a physician, but a very poor electrician. The reason for this disintegration and absorption is as follows:

The x-ray produces disintegration or decomposition, and if the strength is increased to an extreme degree, electrocution is the result.

The x-ray is a germicide. In March, 1896, Prof. Wightman and myself destroyed the bacilli of eight different diseases in the culture tubes by the aid

of the x-ray. In the same month, I placed the first tubercular patient under treatment, and I will say that the patient is still alive and enjoying fairly good health, and what is more, the whole scientific world have acknowledged the fact that the x-ray is a germicide, and they are now treating tubercular patients both in France and Germany. On December 6th and 7th of 1896, the Associated Press published the following statement made by me in defending the x-ray as a healing medium:

"Recently much has been published about the injurious effects of the x-ray upon the human body, such as its producing abscesses, burning and blistering of the skin, shedding the hair and finger nails, etc., etc. For the last eight months I have had patients under the x-ray in my labaratory from 9 A. M. to 6 P. M., duration of treatment varying from a half hour to four hours at each sitting, and not once with any bad result in any case.

"After the Crookes tube is excited by the coil, the magnetic lines of force are projected down, in the same manner as they pass off from a magnet, and traversing the intervening space, pass through the body down to the floor, and back to the coil, and tube again, completing the circuit.

"The x-ray is electrostatic in character, and of a very high potential. With every discharge from the Crookes' tube, oxygen is liberated in the body as well as the surrounding atmosphere, which, combining with nascent oxygen, forms ozone.

"It is due to the electrolysis produced in the body that we are able to destroy the bacilli in contagious disease; ozone being the most powerful germicide known.

"The ozone generated between the tube and the body does not produce the burning, etc., noted; it is the increased current which, passing through the body, produces electrolysis, the skin being of a higher resistance than the rest of the tissues.

This same condition of burning takes place under the galvanic and static currents, if excessive use be made of them. Except for potential alone, the two forces are identical.

"In one of the Eastern states criminals are electrocuted. Here electrolysis is carried to an extreme, destroying the whole body, but the product of partial destruction exhibits abscesses, etc.

"In the disastrous treatment given and reported, the unskilled operators used a current in the apparatus of too high tension, and instead of hastening normal physiological change, carried their treatment to a point of electrocution. Strychnine is a good drug when used by a skillful physician, but a danger in the hands of a tyro.

"It must not be forgotten that electric phenomena are very powerful, and not every man who can buy a machine is capable of applying it. The electric machine must be as skillfully adjusted to each individual as the microscope to a specimen submitted to it. It is a treatment full of danger if ignorantly or rashly handled, but beyond price in value to the skilled and careful electrotherapeutist."

The diagrams of Figs. 1, 2, 3, 4, I do not claim are absolutely correct in detail, but only in general. For instance, from all experiments I have conducted so far, I am led to believe that the lines of magnetic force are thrown off at right angles to the surface of the vacuum tube. The more nearly flat the surface of the tube, in the field of bombardment, the greater the concentration of the lines of magnetic force, and consequently the more perfect the picture.

The apparatus for demonstrating was kindly furnished by Charles Truax Greene & Co.

IZAMBARD PROCESS OF PRINTING BY X-RAYS.

George Izambard, who has been experimenting in Paris with the Roentgen rays in the hope of adapting them to commercial use in the printing industry, announces that he has succeeded in producing a machine for the purpose. He reasoned, it is said, that if the x-rays would penetrate oaken logs they ought to penetrate piles of paper, and that as photographs could be taken with x-rays, it ought to be possible to reproduce a picture or printing through every sheet of a pile of paper. The invention is so far matured, that, according to some of our exchanges, M. Izambard is able to expose a pile of paper between two Crookes tubes and print both sides of all the sheets in the pile at the same time. He can also place a series of piles of paper around a Crookes tube, making use of the x-rays by radiating them from a centre.

It was suggested many years ago that the printing of the future would be done by electricity, operating, not on single sheets, but on all the sheets of a pile at the same instant. Various inventions have made some approach to a solution of the problem, but none of them has been successful in producing satisfactory printing. M. Izambard's first success was obtained by sensitizing the paper, on the side that was to be printed, with a gelatino-bromide emulsion, such as is commonly used in photography. A pile or block of paper thus prepared was placed in a position of exposure to the x-rays. On top of the paper was placed a copy of the thing to be printed. This copy being proof to the x-rays, in a trice the thing was done, and on developing the pile of paper the inventor found a copy clearly printed on each sheet.

To print in this manner, it is necessary that the copy or original shall be nearly impervious to the Roentgen rays and that it shall be placed between the Crookes tube and the pile, where the rays may be directed to it. The copy is preferably first printed or written in what is called radiographic or x-ray proof ink, composed of a material calculated to intercept the rays. A few seconds' exposure is sufficient to effect the printing through the entire pile of paper, but it is at first invisible and requires to be developed or fixed, after the method of a photographer. The piles of exposed sheets are trundled into a red-light room and suspended in vats, where the developing and fixing liquids are applied. Rinsing and drying follow, and the latter may be hurried by mechanical and chemical means. It is apparent that the process is really a sort of wholesale method of photography with the x-rays, and is printing only in the photographic sense of the term.

The inventor admits that there is a difficulty in printing on one side only of the paper, owing to the tendency of the print to show through on the reverse side. He proposes to overcome this by sensitizing the paper in stripes, printing the lines on the stripes, and causing the lines on one side of the paper to fall opposite the spaces between the stripes on the other side. Until he can improve upon this method the process must be limited by these restrictions. To offset this drawback, there are peculiar advantages in the process. It is just as easy to print in white on a black ground as is black on a white surface. Type-written matter can be reduced in size and reproduced, thus saving the expense of composition.

For printing very large sheets, such as newspapers, M. Izambard uses several Crookes tubes, which are shut off from one another by partitions of a metal not easily penetrated by the rays. Thus the tubes send their rays through the paper in nearly straight line. The limit

if thickness of the pile that can be printed at one exposure is reached when the rays are so distributed as to distort the image. Probably no pile of more than a couple of inches in thickness could be impressed at a single exposure with satisfactory results.

The x-ray proof ink used is made in part of finely divided metallic or calcareous powder. Bronze, copper, white lead or white zinc may be used. As a writing ink white lead in a solution of gum has been found most satisfactory. When the matter to be printed is first typewritten, the metallic powder is mixed with boiled linseed oil.

A peculiarity of this x-ray printing is that it affords opportunity for printing copies of private or secret matter, without the printer's being able to see or read what he is printing. A customer desiring copies of private matter may deliver his copy written in the x-ray proof ink and securely sealed in an envelope. He may also see that the paper on which the copies are to be printed is securely sealed. Then the printing may be done by the x-rays and the developing, executed without once breaking the seals, so that no one through whose hands it passes can know the contents. If desired, the envelopes may even be made of stout canvas or leather and securely locked.—*Electrical Engineer, N. Y.*

Measuring the Area of the Heart.

In view of the difficulty of measuring the area of the heart upon the anterior thoracic wall by percussion or phonendoscopy, M. M. G. Variot and G. Chicotot advocate the use of the fluorescent screen. It is easy, they say, to trace with a pencil the radioscopic image of the heart on tracing paper fastened to the screen. This, of course, does not give the true size of the organ, but magnifies it; but when one knws the distance between the anode of the Crooks' tube and the screen and the distance of the anode from the heart, it is a simple application of the rule of three to correct any given diameter of the radioscopic image. The distance of the heart from the anode can be calculated by subtracting the distance of the screen from the heart from the distance of the screen from the anode, and the distance of the screen from the heart has been determined in the case of young children by a series of observations upon cadavers, supported by calculations made in living children confirmed in autopsies. The distance that separates the right and left borders of the heart from the surface of the skin varies with the age of the child; it is about 25 centimetres (one inch) at 18 months, 3 cm. (1.125 inches) at 2½ years, 4 cm. (1 9-16 inches) at 5 years, and about 5 cm. (2 inches) from 10 to 12 years.—*Journal of Electro-Therapeutics.*

Therapeutic Effect of the Roentgen Ray.

Southgate Leigh, M.D., reported to the Seaboard Medical Association a few cases which bear on this subject. The first was that of a young man with a bullet in the thigh. At the time of the examination the knee was very much swollen, exquisitely tender and painful. The slightest touch or motion made him cry out in agony. The doctor, having at that time an imperfect coil and poor tube, exposed the knee to the x-rays for four hours, in order to get a photograph. The next day the patient moved about the bed without pain; the second day he was up in a chair, and the third day he was walking around on crutches.

A second case was one of tuberculosis of the elbow joint. Prof. Wyeth had advised excision. Nicola Tesla, when consulted, advised a trial of the x-ray. Accordingly, the joint was exposed to the ray two or three times a week for two hours each time, until the total exposure was about twelve hours. After

each exposure a wet dressing was applied. In a short time all signs of inflammation had disappeared, and now eighteen months have passed without any return of the diseases.

The third case was an examination for gall stones. For several months the patient had been suffering frightful attacks of pain at frequent intervals. No stones were found on examination, which was prolonged. Since the examination, however, the man has not had an attack, and is in perfect health. Two other cases of a similar nature were apparently relieved by the use of the ray.

THE X-RAYS AT OMDURMAN.—In a recent paper read before the Roentgen Society, Surgeon-Major Battersby related his experiences in the use of X-rays in the last Soudan campaign. After the battle of Omdurman 121 British wounded were taken to the base hospital. In twenty-one cases the bullet could not be found, and in twenty of these an accurate diagnosis was obtained by the use of the rays. The electric current was obtained from E.P.S. cells charged by a hand dynamo, and much ingenuity was displayed in utilizing the back wheel of a tandem bicycle, stripped of its tire and geared to the dynamo, for driving power.—*The Med. Surg. Review of Reviews.*

THE Mississippi Valley Medical Press Association has been organized in St. Louis with an initial membership of 15, Dr. C. H. Hughes is president. The selection of Dr. Hughes as president speaks well for the organization as he is one of the most scholarly and widely known physicians in the world.

The object of the Press Association is to further the interest of Medical Journals wherever the English is read, fraternize more closely the editorial members and aid with all its might the success of the Louisiana Purchase Exposition.

Missouri State Medical Association.

Officers: President, G. R. Highsmith, Carrollton.

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The annual meeting of the Missouri Medical Association will convene in Sedalia, Mo., on Tuesday, Wednesday and Thursday, May 16 and 17 and 18, 1899. All members of the profession are cordially invited.

A notable feature of the programme this year is that three-fourths of it is furnished by members practicing in the country. The claim heretofore made, that the city members monopolize the time, cannot be justly made this year, as it has been the aim to give the country practitioners every opportunity to present the results of their labors.

The Medico Chi. Wins.

Supreme Court says it can grant degrees in dental surgery. The Medico-Chirurgical College petitioned the Common Pleas Court No. 3, for leave to amend its charter so as to grant the diplomas and degrees in dental surgery, etc.

This was resisted by the Philadelphia Dental College on the ground of want of authority to do so, etc. The Common Pleas Court decided in favor of the Medico-Chi., and the Dental College took an appeal from his decision. The Supreme Court in an opinion by Justice Dean, this morning confirmed the decision of the lower Court, and dismissed the appeal. L. Webster Fox is Secretary of the Board of Trustees.

DURATION OF ROENTGEN RAY EMISSION.—Roiti, Trouton and Colardeau have by various means endeavored to ascertain the duration of a single x-ray impulse. The values arrived at varied from 1-300th to 1-10,000th of a second. H. Morize has devised and carried out a method of determining this duration, which he believes to be capable of great accuracy. A photographic plate is fixed on the end of the shaft of a highspeed motor. A metallic slit is mounted in a radial direction just in front of the plate. Photographs are taken when the motor is at rest and when it is moving at a known speed. The images of the slit appear drawn out sideways when the plate moves, and the amount of the broadening is a measure of the duration of the x-ray impulse. The results obtained by this method show that to each current impulse in the primary of the induction coil there correspond several successive impulses of the rays. Successive images of decreasing intensity are thus produced, separated by uniform intervals. On some plates four images can be traced, the last being very feeble. The durations obtained ranged from 65 to 107 millionths of a second, with a mean of 82×10^{-6}. The intervals were 0.00033 sec. on the average.—*Morize, Comptes Rendus*, Oct. 17, 1898.

healing waters, restoring health to those who use it. For persons who experience evil effects from drinking, it is especially efficacious, clearing the mind and cleaning the system. Headquarters of Rothwell's B. B. Mineral Spring are at 2937 Olive street. All orders are filled promptly and any information or advice desired cheerfully given. J. S. Rothwell, the manager, refers to the following well-known gentlemen: Allen and Geiger, 714 Olive street, Meyer Bros. Drug Co., John G. Joyce, Surveyor; Gov. Colman, *Rural World*; F. R. Dunn, commission merchant; Wm. N. Tivy, commission merchant; F. W. Brockman, commission merchant; Arthur Kruer, Lafayette Brewery; J. H. Farley, Merchants' Exchange; Fred Deibel, Hay and Grain Exchange, and thousands of others. Where the names of such fair-minded people can be used it is worthy the consideration of fair-minded people.

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